# INCANDESCENT LIGHT
# THE HEALTHIER ALTERNATIVE?

**_The fact that incandescent light matches natural sunlight much better than any other types of lighting seems to support a small body of scientific and anecdotal evidence that it is the healthier option._**

**_Part 1 of 2_**

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Over the last couple of decades I've had a growing suspicion that fluorescent light may not be very good for our health, and that incandescent light may be much better. However, it was not until my training and work as an interior design colour consultant in the early 1990s that I learned that fluorescent light really is quite inferior in quality compared with incandescent light, and I have since spent much time trying to find out what else sets them apart.

So let's begin by looking at the technical differences between incandescent and fluorescent lamp types.

• The **incandescent light bulb**, Edison bulb or GLS (General Lighting System) lamp, consists, as most people probably know, of a glass bulb in which a spiralled super-thin tungsten filament is heated by electricity until it glows. It is kept glowing at a slow, even pace by the bulb having been emptied of air and instead often filled with an inert gas like argon. As implied by its name, this is a form of *firelight*—exactly the same natural element as in sunlight or candlelight, only concentrated and safely contained. This is the first reason why incandescent light may be healthier.

• The **halogen lamp** is a smaller, more compressed incandescent lamp made out of thick heat-resistant quartz glass into which a halogen (usually bromine) is added which creates a recycling process of the tungsten particles that makes the halogen lamp give about twice as much light and last 2–4 times longer than a standard GLS lamp. Besides the tiny low-voltage bulbs usually used in spotlights, fairy lights and car headlights, there are also mains-voltage lamps (that give only about 20% more light but don't require a transformer). These usually come in the form of a mini tube, but some of the newer ones have outer bulbs that resemble GLS bulbs and have the same kind of socket.

• The **fluorescent light-tube**, invented in the 1930s, is a glass tube filled with a gas like neon or krypton and some mercury vapour. At each end it has an electrode connected to ballasts in the fixture that rapidly turn them on and off to create a continual series of electrical discharges which make the mercury atoms produce an excess of energy in the form of ultraviolet (UV) light. This UV-C light is then turned into visible light by a combination of phosphors which form a fluorescent layer on the inside of the tube. *Synthetic* light is what I would call the product of this complicated process. Its main advantage is that it gives more light per watt than both GLS and halogen lamps.

• The **high-intensity discharge** (HID) lamp works in a similar way, but in most of these it is mainly the gas that produces the light directly. It is shaped like a mini tube or a large elliptical bulb that requires special fixtures and ballasts, and is often used outdoors.

## Measuring the Differences

There are certain ways to measure the differences between the various types of lights.

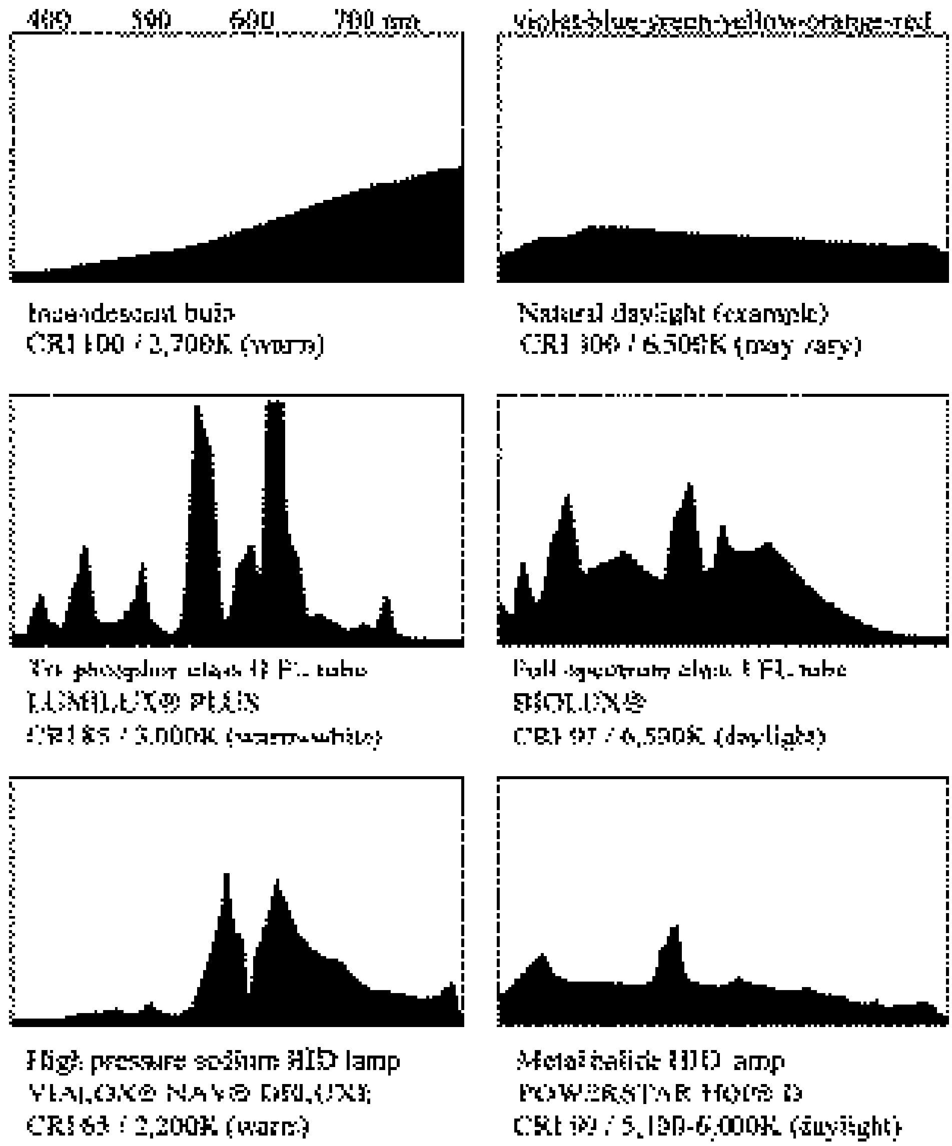
• **Spectral Distribution** (SPD) refers to which wavelengths of the spectrum are present, and in what proportions, in the light from a given light source. This in turn determines both the colour of the light and its colour rendering capacity.

• **Colour Rendering Index** (CRI) is a measure of how accurately the colours of an illuminated object or surface can be seen compared with how they look under a reference light, and is usually divided into five categories of quality: CRI 90–100 is "accurate" (more or less); CRI 80–89 is considered "good" (or "fairly good"); CRI 60–79 gives moderate colour rendering; CRI 40–59 has poor colour rendering; and CRI 0–39 is very poor.

• **Correlated Colour Temperature** (CCT) is measured in degrees Kelvin (K). Just as a smith can tell what temperature the metal is by looking at the colour (the hotter it is, the whiter), the colour of the light is determined in incandescent lamps by the temperature of the tungsten filament (which is around 2,700 K in GLS bulbs and up to 3,300 K in halogen lamps). In fluorescent and HID lamps, the colour and SPD are produced by the different colours of the phosphors and/or gases they contain (which, when added together in various combinations and proportions, appear to the eye as white, orange-white, pink-white or blue-white light) and the CCT that each colour type is designated is the one it visually most closely resembles. The temperature scale for light is often divided into four groups: 1,700–2,900 K is called "warm"; 2,900–3,300 K, "warm-white"; 3,300–5,000 K, "cool-white"; and 5,000–10,000 K, "daylight".

All incandescent lamps, including halogen, produce a top-quality golden-white light with perfect colour rendering capacity (CRI 100), since it has a *continuous* spectral distribution that is not fragmented like fluorescent light is. This is another reason why some of us believe incandescent light to be healthier.

Examples of spectral power distribution charts for a few typical light sources. Drawn from Osram charts with permission.




## Fluorescent Light Characteristics

Fluorescent light (FL) comes in many different colours and qualities, but despite so much effort being put into trying to copy the colour and quality of incandescent light and sunlight, most FL and HID lamps still produce a light that usually looks and feels more or less unnatural since it is not based on the element of *fire*. In a spectral power distribution chart, FL creates a ragged line with peaks at various individual wavelengths and drops in others.

As the FL or HID lamp ages, its light becomes progressively weaker and even more cold and unnatural-looking because the phosphors that produce the red part of the light are exhausted before the ones that produce the green and blue parts. This means that even if a lamp keeps on functioning for, say, 16,000 hours, you may still need to replace it after only about 10,000–12,000 hours. Depending on the tube's quality, these characteristics may be more or less pronounced. FL can be divided into three groups:

- **Class III:** The basic halophosphate group includes the standard cool-white tubes with moderate colour-rendering capacity (CRI 60–76), and the warm (pink) tubes of even poorer quality (CRI around 50). These produce a bleak light that distorts colours, since they only reproduce some of the wavelengths of the spectrum. They have until recently been the most commonly used tubes, and in many countries still are, despite the fact that they are not even very economical to use.
- **Class II:** Tri-phosphor or three-band FL, including the new slim tubes with improved efficiency and the compact fluorescent, have better colour rendering (CRI 82–85) and usually come in warm to cool-white. They are gradually replacing the class III as the new standard tubes.
- **Class I:** Multi-phosphor or full-spectrum (FSFL) tubes and compact fluorescents usually come in daylight colour only, but some make them in warmer hues as well. These FSFLs have five phosphors, giving their light better spectral distribution and colour rendering (CRI 90–98)—although mainly in a fairly superficial way, since, like tri-phosphor FL, it is still a *composite* light. But just as you may produce an alloy that looks like silver or gold by mixing several non-precious metals, this does not *make* it silver or gold nor give it the same properties, of course.

The term *full spectrum* is really a misnomer. The only artificial light sources that reproduce all the wavelengths of the visible spectrum are the incandescent bulb and the halogen lamp. Check this out for yourself, if you like, by doing your own spectral analysis with the back of a CD in a dark room.[1] First, turn on an incandescent lamp and you can see the whole visible spectrum perfectly reproduced and all the colours looking rich and luminous. Then turn on an FSFL instead and you will see the colours looking much more faded and the spectrum being fragmented by curious lines here and there which are actually gaps where certain wavelengths are missing. A class II lamp gives an even more distorted spectrum. Here you see clearly the three colours separated into distinct bands and how the red and the green overlap to produce yellow. The intermediate wavelengths are missing altogether.

The white or warm-white light from the new *indium-gallium-nitride* LED lamps is also a composite light produced by a combination of red, green and blue.

### Problems with Flicker

If we all had our own or local power generator, we could be using low-voltage direct current (DC) everywhere and not just in cars. Instead, we have alternating current (AC), which is used to keep power lines from overheating and too much power being lost on the way when sending electricity over long distances. This use of high-voltage AC is something very unnatural. Naturally occurring AC fields are rare and usually weak.[2]

One of the problems with AC is that when it is used to power electric lights, the light intensity fluctuates in synchrony with it at twice the AC rate: 100 times per second in a 50 Hz power system (as in Europe and Australia) and 120 times per second in a 60 Hz system (as in North America).

In incandescent lamps, this modulation is fairly small because of the tungsten filament that keeps glowing between pulses; but in FL tubes powered by conventional magnetic ballasts, the variations are much bigger, resulting in continual flicker. This flicker is not seen by the eye until it slows down towards the end of the tube's lifespan, but may nevertheless be perceived subliminally by the body and the brain.

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In a study on healthy people of various ages, Küller and Laike (1998) at the Lund Institute of Technology found that even though subjects couldn't actually see the flicker, many still preferred the non-flickering light source, and that about 40%, mostly younger and less addicted to alcohol and nicotine (indicating a more alert nervous system not dulled by age or intoxication), were more sensitive to flicker and reacted with decreased alpha brain-wave activity, increased speed and more errors in performance.[3] They also mention other studies—such as the ones by Wilkins et al. (1989), linking flicker from FL to headache, eye strain and general stress; by Colman et al. (1976), finding that autistic children became more distracted and stuck in repetitive behaviour (a sign of stress or trance) under FL than under incandescent light; and by Zaccaria and Bitterman (1952), whose subjects preferred FL tubes powered by DC to those powered by AC.

But instead of solving the problems with flicker simply by using incandescent light instead or by switching back to DC (which could be done by a local converter), a new technology has been introduced during the 1990s: electronic high-frequency (HF) ballasts that increase the switching on-and-off rate from 100 or 120 to up to 60,000 times per second! This HF technique gives the impression of a more even light-flow, since it is so rapid that the FL does not have time to go out between pulses. It is now being used more and more in class I and II FLs, including most "energy-savers" (which, in that case, are marked "electronic" and light up gradually instead of with a flicker when you turn them on). Whether or not this HF light is really as good for us as manufacturers claim, remains to be seen.

Torkel Morgell, founder of the Stockholm Association for Ecological Technology (SET), says that all AC electricity disturbs the hydrogen atoms in the body and that speeding up the frequency doesn't exactly make it more restful or healthy.[4]

### Electrical Hypersensitivity

Of the growing number of people who have become electrosensitive (ES) and experience various symptoms like eye irritation, skin rash, headache, dizziness, nausea, fatigue, breathing difficulty, irregular heartbeat, etc. when working with computers, most have a problem with fluorescent light too—FL, in fact, being the second most common source of complaint[5]—but often seem to feel okay with incandescent bulbs.

Two separate studies, at the National Institute for Working Life in Stockholm and Umeå respectively, found that the electrosensitives (ESs) they tested also seemed to be more *naturally* sensitive and reacted more strongly than others to flicker from FL or computer screens as well as to other sensory stimuli such as unexpected sound and touch.[6]

Unfortunately, however, some have over-interpreted these results—which appeared very conveniently just when the lighting industry was trying to promote the new HF technology—and now see HF ballasts as the solution to all ES problems.[7] Roger Wibom, responsible for the Stockholm study, claims that when switching to HF-powered lights, the ESs he tested had fewer symptoms and felt better,[8] but all the electrosensitives whom I have talked to personally, as well as representatives of their organisation here in Sweden, FEB, say that they *don't* feel better with HF; some even suspect it of being the *cause* of their problems, since these started around the same time that HF was introduced in their offices.

Considering the fact that many ESs also react to cellphones, which clearly don't flicker, and to low-voltage halogen lamps, which due to their thicker tungsten filaments flicker even less than GLS lamps[9] but instead have transformers that can radiate strong magnetic fields, there must certainly be other factors involved.

According to biochemistry professor Per-Arne Öckerman, MD, who, with more than 35 years' experience in medical research, has successfully been treating ES and other environment illnesses,[10] there seems to be a strong connection to toxic overload in the body.[11] These toxins could in some cases *even come* from the FL tubes and computers themselves, since both may emit various more or less harmful chemicals;[12] or could possibly come from mercury dental fillings —which, according to Friz-Uno Johansson, may leak mercury when exposed to magnetic fields.[13].

Since so many electrosensitives get skin reactions, I also wonder if in some cases this may not be a *photo-toxic* reaction (a hypersensitivity to light) that can by caused by some medical conditions,[14] by perfume on the skin, and by certain anti-inflammatory, anti-depressive and antibiotic medicines[15] that can temporarily make patients so hypersensitive to UV light that they cannot tolerate even the very tiny amount of harmless UV-A that windows let through or that standard office tubes emit. Since television and computer screens are also light sources (with LCD screens often being lit from behind by micro FLs or LEDs) and since many people use medicines and/or after-shave and skin-care products with perfume and are forced to work in FL all day, could there be a connection? I've also noticed how close to the computer most people sit. If you have a laptop, there isn't much choice, of course; but when the screen is separate, why not move it back quite a bit onto a separate table? You'd never dream of sitting that close to your TV, would you?

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### Mercury Vapour

Besides discovering in the 1970s that FL tubes emit radio waves (if not properly grounded) and low levels of X-rays from the cathode ends of the tubes, Dr John Ott claimed that they also leak mercury vapour.[16] This could perhaps also explain why people who have been mercury poisoned by their dental fillings often become hypersensitive to FL, too.

If FL tubes still leak mercury vapour, the levels should, however, be significantly lower now, since modern tubes contain so much less mercury (3–5 mg in class I and II, and around 15 mg in class III tubes, according to leading manufacturers) compared with the old class III tubes, which could have as much as 50 mg.[17] Some of the slim new class II tubes like the Philips TLD also have an extra protective layer on the inside of the tube to prevent mercury vapour from merging with the glass, since that affects the amount of light that gets through.[18] Perhaps this also prevents any mercury from leaking out.

Incandescent lamps do not contain any mercury at all—only a little bit of lead at the bottom, but that's in a solid form which cannot be inhaled.

### Full Spectrum Light

Even though I very much agree with most other things in Jacob Liberman's *Light: Medicine of the Future*,[19] in Joseph Hattersley's article about full-spectrum light in NEXUS 8/04,[20] and in Simon Best's article about ADHD in NEXUS 8/06,[21] and have no trouble accepting the possibility that class I FL may be less unhealthy than the old class III tubes—especially when used in radiation-shielded fixtures like the Ott bioLight—I do not agree with the opinion that "full spectrum" fluorescent light (FSFL) is the best artificial light there is. Nor with the idea that it is just as healthy as real sunlight and may be used to replace it. FSFL is still fluorescent and mercury-based and has just about nothing in common with sunlight, except that some FSFLs are designed also to emit tiny amounts of extra UV-B. So citing studies that show the benefits of natural sunlight in no way proves that FSFL would be healthy, too.

To find out if FSFL is better, one must of course use it in one's studies, and this seems to have been done in quite a substantial number of cases. However, Jennifer Veitch (National Research Council, Canada) and Shelley McColl (Department of Psychology, McGill University, Montreal), who recently published two reviews of the relevant studies made between 1941 and 1999 regarding the effects of FSFL on perception and learning and on physiology and health, found that a surprisingly large number of the studies were not properly conducted and concluded that, with few exceptions, the best studies did *not* show FSFL to be more beneficial than the light from other common (usually FL) light sources.[22, 23]

In the very few cases where FSFL really has been found to be very effective, mainly on SAD (Seasonal Affective Disorder) and similar conditions, the same results have later been achieved with other bright lights, even coloured ones.[24] To have an anti-depressive effect, to "reset the biological clock", etc., it seems to be *brightness* rather than colour or spectral distribution that matters. So, early studies (e.g., by Rosenthal et al., 1984) that compared bright FSFL only with dim controls, either fluorescent or incandescent, do not prove that FSFL works and other lights don't—only that dim light is insufficient.[25] They also point out the fact that natural outdoor daylight, even on a cloudy day, may be more than 100 times brighter than the lighting indoors, that its colour temperature may vary between 5,000 K and 10,000 K depending on weather, season and time of day (and latitude, one might add), and that it is also polarised, which FSFL and other artificial lights usually are not.[26]

Unlike myself, however, Veitch and McColl don't believe that lamp type matters much at all, and because *fewer than half a dozen* of the hundreds of studies that appear to have been done on the effects of different light sources seem to have included incandescent lights, it is hard for me to "prove" that they are healthier, other than by logical deduction and so-called anecdotal reports. Since I've started to talk with people about light, I've been surprised to find such a large number of individuals who also prefer incandescent light and report feeling more or less ill or uncomfortable under FL. Tom Entwistle at the bioLight Group (formerly Ott bioLight) says that of the thousands of people they've interviewed about how they feel about FL tubes, 100% said they absolutely hate them![27] However, despite my pointing this out, none of the lighting researchers I've talked to has shown the least bit of interest in including any kind of incandescent light in their studies!

### Effects of Extra UV-B

As for potential health effects from adding a little extra UV-B to indoor lighting, a few of the studies reviewed by McColl and Veitch did seem to indicate a positive effect on the metabolism of vitamin D and thereby on calcium absorption and dental caries from using FSFL with extra UV-B; but since the amount of UV-B added was so small, McColl and Veitch consider it "negligible for people with outdoor exposure" and don't rule out other factors contributing to the effect.[28] Hopefully, future studies may bring further clarification.

If it can be firmly established that extra UV-B really is necessary, if it can be determined what dose is needed and are safe for each individual (since this may vary a lot depending on pigmentation, etc.), and if it can be proved that *artificial* fluorescent UV-B is as good as moderate doses of natural UV-B from the sun are said to be, then extra UV-B may be added to any artificial light source and need not come with FSFL only.

A tip for those who may want to try an FSFL tube with extra UV-B is to make sure to ask for specifics when you buy it, since some of the major manufacturers have now jumped on the "full spectrum" trend and are selling "health-promoting" FSFLs with "extra UV" that include only UV-A.

And if anyone would like to try an incandescent alternative to a fluorescent light-box for home treatment of SAD, I suggest using the (indirect) light from one or several 300-watt or 500-watt halogen floodlights, of the mains-voltage mini-tube type that comes in a rectangular light fitting and which can be bought at a low price in a hardware store. I find that, besides effectively "recharging one's batteries" if only it is bright enough, halogen light also has the advantage of looking and feeling very much like real sunlight.

Let me add here that halogen lights are now perfectly safe to use. It is correct that they produce a tiny bit of UV-A, UV-B and UV-C, and that the quartz glass that the bulbs are made of does not stop most of it like ordinary glass does. But since this was brought to the attention of the lighting industry in the early 1990s, virtually all halogen lamps sold today have a front glass that stops UV (and keeps the bulb from accidentally falling out and starting a fire) and/or an extra UV filter on the bulb itself that reduces all UV-C, all or most of the UV-B and about half of the UV-A. (If one would actually like it to give off more of the beneficial UV-B, I'm sure the filter could be modified to stop the UV-C only. Probably, however, it would still be so little that it wouldn't make much of a difference anyway.)

So the only thing one needs to think about is to keep these halogen lights out of reach of children, as they still do get very hot. Also, they can often be quite glary if not positioned correctly, unless used in one of those glare-free, state-of-the-art light fittings that dentists and surgeons use, which cost a fortune.

### Colour Temperature

Although differences in colour temperature and spectral composition have not been found to have any significant effect on health and performance, they may still influence how you *feel*. Even if the intention was good, I think designing tubes to produce cold-coloured light was a great mistake. Let me clarify here that full-spectrum light is not meant to imitate sunlight but, instead, the much cooler light of a cloudy or hazy summer's day, or a skylight from the opposite direction to the Sun on a clear day, since that has been found to be *visually* ideal, especially for tasks that require reading and distinguishing colours. But as you can see, both directly and in a spectral power distribution chart, it is not a perfect replication even of that, but more of a greenish-blue rather than like the balanced clear-white colour of real daylight.

But even if it were possible to reproduce the spectrum of daylight more accurately, would we really want to use it to work in all day? For if we are looking for a light that makes us feel better, is it not the warm glow of sunlight that so lifts one's spirit rather than the cold, gloomy light of a cloudy day? And if one is to go by what we may be adapted to in an evolutionary sense, isn't it true that indoors, and during the dark part of the year and day, we are, as far as we know, historically used to the even warmer light from hearths, torches, oil lamps and candles?

Perhaps this is why most people spontaneously prefer the light of a warmer colour,[29] and may not be as comfortable in FSFL as some seem to think we should be. In a study by Küller and Wetterberg (1993), subjects experienced more discomfort under FSFL of daylight colour than under class II warm-white tubes and rated the social status of the room as much lower when illuminated by the colder light—which confirmed the results of an earlier study (Küller, 1982) that showed office workers reporting more visual complaints when exposed to the FSFL than under standard class III white tubes and finding the daylight colour "unpleasant and cool", especially at night.[30] Many of the other studies reviewed by Veitch and McColl showed similar results. Even in the few cases where FSFL was actually preferred, they point out the very likely possibility that it might be due to the better colour rendering rather than the colour of the light.[31]

**Although differences in colour temperature and spectral composition have not been found to have any significant effect on health and performance, they may still influence how you *feel*.**

But to be of good quality, a light does not necessarily have to be so cold. If one wants to use FSFL, there are other class I tubes with equally high CRI that give a warmer light. And as shown earlier, incandescent light reproduces colours better than even the best FSFL.

I'll admit, though, that incandescent light, at the luminance levels usually used indoors, does give colours a bit of a golden shimmer compared with how they look in daylight; but in my opinion, that only looks natural and appealing especially when it falls on and enhances the warm colours of most natural materials and living beings as well as on the predominantly warm colours with which most of us seem to prefer to surround ourselves.

So why, then, are so many designers, architects and others constantly trying to promote both light and colours that are unnaturally cold and bright, as well as cold and hard materials and sharp geometric shapes? Even if some of the best designs may be interesting to look at, does anyone really want to live or work in something that is both designed and lit like a morgue? Or use a light that makes our skin tone look as if we belong in one?

Even the *neodymium light bulb*, which some recommend as an incandescent daylight alternative, feels a bit odd to me because of the very unnatural purple-white hue that the neodymium coating creates. According to Sylvania, this lamp was designed primarily for plants, which are said to grow more lushly in red-blue light.

I would also like to comment on a couple of things in Dr Jacob Liberman's otherwise very enlightening book that I feel he may have misunderstood about the colour of incandescent light (and I hope he won't mind if I do).

On page 146, he expresses his concern that the warm colour of incandescent light might be unhealthy for humans, based on Dr John Ott's experiments where wavelengths in the orange-pink-red range caused serious health problems in animals.[32] These often quite horrible effects were, however, not produced by incandescent light but by *monochromatic* light. That being exposed to one single wavelength (colour) at a time—which, as Dr Liberman himself describes, can also be therapeutically beneficial in limited doses—may be harmful for animals and possibly for humans, too, if used for a prolonged period of time, has nothing at all to do with incandescent light.

On page 145, Dr Liberman claims that "most light bulbs give off gross distortions of the visible light spectrum, emitting strong peaks of light energy in the yellow, red and infrared portions of the spectrum", and he calls this "*highly unnatural*" (his emphasis).[33] As for the infrared part, both sunlight and candlelight produce much heat, too (as does FL, although not quite as much). But what's wrong with that? Isn't infrared as much a part of a "complete" spectrum as ultraviolet? And in an SPD chart, incandescent light does *not* produce peaks at various individual wavelengths as FL (including FSFL) does, but, instead, produces a soft-flowing *curve* since it has a continuous spectrum, just like sunlight, and is warmer, more golden in colour (with emphasis in the warm end of the spectrum) mainly because its luminance is so much lower. Sunlight, too, is whiter in the daytime and gets warmer towards the evening as it becomes less bright, right? If you compare, for example, a 100-watt light bulb with a 25-watt bulb, or have a dimmer that you turn down, you can see that the brighter the light is, the whiter it looks. What could be more natural than this?

So, since the colour temperature seems to adjust itself automatically in incandescent light to suit the situation perfectly—and gets whiter and more activating when you turn it up, and warmer and more relaxing when you turn it down, why meddle with the spectral composition at all? Why not just use a combination of bright incandescent light and real daylight for work/in the daytime, and then use softer incandescent light—or even candlelight if you feel like it—for leisure/at night?

**Continued next issue…**

## Endnotes

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